I-405 Congestion Relief and
Bus Rapid Transit Projects
Kirkland Nickel Project

I-405, SR-520 to SR-522 Stage 1
Draft Stormwater Infiltration Report

Washington State
Department of Transportation

January 2005

Geotechnical Report
I-405 Stormwater Infiltration
Kirkland Project
Kirkland, Washington

January 17, 2005

Prepared for

I-405 Project Team
Washington State Department of Transportation

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1.0 INTRODUCTION

This report provides a summary of the geotechnical engineering services conducted to support evaluation of the feasibility of infiltration at three sites along the I-405 corridor in Kirkland, Washington. The purpose of our services was to complete insitu infiltration tests to evaluate the feasibility of infiltration for disposal of stormwater runoff.

The general project location is shown on the Vicinity Map, Figure 1. Figures 2, 3, and 4 show the location of each of the test sites and the approximate location of the explorations completed at each site. Appendix A presents a description of the field exploration program, summary logs of conditions encountered in the explorations, and the results of the geotechnical laboratory testing. Appendix B presents copies of summary logs, provided by WSDOT, of nearby explorations.

1.1 PROJECT DESCRIPTION

We understand that infiltration is being considered for disposal of stormwater runoff from the Kirkland portion of the I-405 corridor, between the NE 85th Street interchange (Exit 18) and the Totem Lake interchange (Exit 20B). Based on preliminary geotechnical investigations completed along the corridor by others, three locations were selected by the I-405 Team to perform insitu infiltration testing. Details regarding size and depth of the ponds have not yet been finalized. A bottom depth of 5 ft below existing site grades was assumed at each location.

The three infiltration facilities being considered include:

- Site 1: An infiltration pond located between the northbound lanes and the northbound onramp at the NE 85th Street interchange, adjacent to project station 4132+00 (MP 18.25).
- Site 2: A bioswale and infiltration trench along the west shoulder of I-405 in the vicinity of the NE 100th Street pedestrian bridge (MP 18.88).
- Site 3: An infiltration pond located on the west shoulder of I-405 about 1000 ft north of Site 2 (MP 19.03).

1.2 SCOPE OF SERVICES

Landau Associates was contracted by Washington State Department of Transportation (WSDOT) to provide geotechnical engineering services to support the project. Our services were provided in accordance with the scope of services outlined in Task Assignment No. AA, dated September 20, 2004, and the terms of On-Call Agreement Y-8096 between WSDOT and Landau Associates. Our scope consisted of the following specific tasks:

- Completed field explorations at each of the three proposed sites. At all three sites, field explorations consisted of excavating 1 to 3 test pits to characterize soil and groundwater conditions.

- At sites 1 and 2, completed a pilot infiltration test (PIT) in general accordance with Section 3.3.5 and Appendix V-B of the Washington State Department of Ecology (WDOE) *2001 Stormwater Management Manual for Western Washington* (WDOE 2001). At Site 3, groundwater seepage was encountered at the planned pond bottom elevation and no PIT test was completed at that location.

- Completed a geotechnical laboratory testing program consisting of visual classification and gradation analyses (mechanical and hydrometer) on selected soil samples.

- Completed geotechnical engineering analyses. Information from the field explorations and insitu testing was used as the basis for evaluating the feasibility of infiltration. The findings, conclusions and recommendations are summarized in this report. The report includes:
  - Site plans showing the location of explorations completed for this study.
  - Summary logs of conditions observed at the exploration locations completed for this study. Copies of summary logs of nearby explorations completed by others are also included.
  - Results of the geotechnical laboratory testing.
  - Discussion of the results of insitu infiltration testing.
  - A discussion of the subsurface soil and groundwater conditions at proposed infiltration locations.
  - Evaluation of the feasibility of infiltration of site stormwater at Sites 1, 2, and 3.
  - Recommendations for insitu infiltration rates at each location.
  - Recommendations for additional testing and evaluation (if necessary) to support the design phase.

2.0 EXISTING SITE CONDITIONS

This section provides a discussion of the general surface and subsurface conditions observed at each of the project sites at the time of our investigation. Interpretations of the site conditions are based on our review of available information, site reconnaissance, subsurface explorations, and laboratory testing. Exploration locations are shown on Figures 2, 3, and 4. Photographs showing details of the infiltration testing are included as Figures 5 through 12. Appendix A provides a summary of the field explorations completed at each site and summary logs of the conditions encountered in the test pits excavated at each site. In addition, copies of summary boring logs, completed by others and provided by WSDOT, are included in Appendix B of this report.

2.1 SITE 1

This section provides a discussion of the surface and subsurface conditions observed at Site 1 at the time of our investigation on October 5, 2004.

2.1.1 SURFACE CONDITIONS

Site 1 is located in the northeast quadrant of the I-405/NE 85th Street interchange at approximately milepost (MP) 18.25 and is roughly triangular in shape. The site is bounded on the north and east by the northbound onramp, on the south by the northbound offramp, and on the west by northbound I-405. The area slopes gently downward from the north, east and west to a shallow depression in the center. The shallow depression extends northward to a stormwater inlet. The area is vegetated with grass and a few scattered, small deciduous trees. The site of the PIT 1 test is located on the slope along the northbound lanes of I-405.

2.1.2 SUBSURFACE CONDITIONS

Subsurface conditions were explored at the site in boring KQ-1-04, completed about 5 ft east of the PIT 1 location by WSDOT on July 23, 2004, and in test pit TP-1, completed for this study about 20 ft north of the PIT 1 test location. Soil conditions encountered in test pit TP-1 were observed to consist of fill over native soil. Fill was observed in the test pit to consist of light brown to gray and light brown to reddish brown, medium dense, silty sand to a depth of about 3 ft, and light brown and reddish brown, loose to medium dense sand with silt to a depth of about 7 ft. What is interpreted as recessional outwash deposits, consisting of gray, loose to dense, sand with silt and silty sand, was encountered to a depth of about 12 ft. Glacial till, consisting of gray, dense to very dense, silty, gravelly sand was encountered below a depth of 12 ft and extends to the depth explored, about 14 ft. Soil conditions observed in test pit TP-1 are generally similar to those described in boring KQ-1-04. Gray, very dense, gravelly, silty sand was reportedly encountered in boring KQ-1-04 at a depth of about 19½ ft, and extends to the depth explored, about 40½ ft. Based on the density and soil description on the summary log, soil below a depth of about 19½ ft appears to be glacial till. The glacial till surface appears to be rising to the north.

Groundwater was not encountered in test pit TP-1 at the time of exploration (October 5, 2004) to the depth explored. A wet zone was reportedly encountered at the time of drilling (July 23, 2004) in boring KQ-1-04 at a depth of about 12½ ft and appears to extend to a depth of about 19½ ft. The wet zone is likely a remnant of the seasonally perched groundwater table above the relatively impervious glacial till. Groundwater levels at the site are expected to fluctuate seasonally with the maximum groundwater level occurring during the winter/spring months.

2.2 SITE 2

This section provides a discussion of the surface and subsurface conditions observed at Site 2 at the time of our investigation on October 12, 2004.

2.2.1 SURFACE CONDITIONS

Site 2 is located along the west side of I-405, about 90 ft north of the NE 100th Street pedestrian overpass at approximately MP 18.88. The area slopes slightly downward from the I-405 shoulder to an existing drainage swale about 10 ft from the edge of pavement. On the west side of the drainage swale, the topography slopes relatively steeply upward at about 30 to 35 percent. The drainage swale and the lower portion of the slope west of the swale are vegetated with grass. The upper portion of the slope is vegetated with a dense stand of deciduous and conifer trees. The PIT 2 test was conducted on the slope about 13 ft (horizontal) from the drainage swale.

2.2.2 SUBSURFACE CONDITIONS

Subsurface conditions at the PIT 2 location were explored by excavating two test pits, TP-2A and TP-2B to depths of 11½ and 9 ft, respectively, below existing site grades. TP-2B was excavated in the center of the pit for PIT 2 after completion of testing. In addition, we reviewed a summary log of a boring completed on May 22, 1998 for the NE 100th Street pedestrian bridge by HWA GeoSciences for WSDOT.

Subsurface conditions encountered in the test pits TP-2A and TP-2B were observed to consist of a layer of topsoil and/or fill, overlying advance outwash deposits to the depths explored. At test pit TP-

2A, fill was observed to consist of light brown, medium dense, gravelly sand with silt and extend to a depth of about 1 ft below existing site grades. A thin layer of surficial topsoil is present at test pit TP-2B. Advance outwash in test pits TP-2A and 2B was observed to consist of light brown to light reddish brown, medium dense to dense sand, to sand with silt with variable gravel content. A layer of gray to reddish brown, hard silt was encountered in test pit TP-2A between a depth of about 5 and 7½ ft, and in test pit TP-2B between a depth of 4 and 6 ft. Groundwater was not encountered in test pits TP-2A and TP-2B at the time of exploration (October 12, 2004) to the depths explored, about 11½ and 9 ft, respectively. Subsurface conditions reported in the boring completed for the NE 100th Street pedestrian bridge are similar to those encountered in the test pits.

2.3 SITE 3

This section provides a discussion of the surface and subsurface conditions observed at Site 3 at the time of our investigation on October 13, 2004.

2.3.1 SURFACE CONDITIONS

Site 3 is located along the west side of I-405 about 1,000 ft north of Site 2 at approximately MP 19.03. The area slopes slightly downward from the I-405 shoulder to an existing shallow drainage swale about 10 ft from the edge of pavement. On the west side of the drainage swale, the topography slopes slightly upward. The area is vegetated with grass. A dense stand of deciduous and conifer trees is located about 25 ft west of the swale. The test pits were excavated just west of the drainage swale.

2.3.2 SUBSURFACE CONDITIONS

Subsurface conditions at the PIT 3 location were explored by excavating three test pits, TP-3A through TP-3C, to depths of 6 ½ to 9 ft below existing site grades. In addition, we reviewed a summary log of a boring completed on April 5, 1991 in the general project vicinity by Rittenhouse-Zeman Associates for WSDOT.

Subsurface conditions encountered in the test pits consisted of a sequence of topsoil/fill over advance outwash deposits. Topsoil was observed to generally consist of about 12 inches of dark brown, soft, sandy silt with gravel and abundant organic material. Fill was observed to generally consist of light brown to gray, loose to medium dense, gravelly sand with silt and extend to depths of about 1½ to 3 ft below existing grades. Advance outwash deposits, consisting of light brown to reddish brown, dense sand with silt with variable gravel content was encountered to the depths explored, about 6½ to 9 ft below existing site grades. Soil conditions encountered in test pits TP-3A through TP-3C were significantly different than reported in the boring.

Moderate groundwater seepage was encountered in all three test pits at depths ranging from about 4 to 6½ ft below existing grades. Groundwater levels at the site are expected to fluctuate seasonally with the maximum groundwater level occurring during the winter/spring months.

3.0 TEST METHODS AND FINDINGS

Based on the results of the field investigation, infiltration of stormwater at Site 1 and Site 3 is likely not feasible. The results of the PIT test at Site 2 indicate that infiltration of stormwater is likely feasible. The following summarizes the result of the infiltration feasibility study at each location and the recommended field infiltration rate for use in design.

3.1 SITE 1

The pit for the PIT 1 test was excavated to a depth of approximately 4 ft 9 inches below the existing ground surface, as measured on the east (low) side of the pit. The bottom area was approximately 22.8 ft^2. The pit side walls were excavated near vertical to a height of 3.25 ft above the bottom. The upper portion of the pit side walls were laid back at an approximate 45 degree angle.

After cleaning of the loose soil from the pit bottom, the instrumentation was installed and the pit was filled with water to a depth of approximately 3.5 ft above the pit bottom. Approximately one hour was necessary to fill the pit with water. Water was continually added to the pit to maintain a constant water level of about 3.5 to 3.6 ft above the pit bottom. After about 2½ hours, the measured flow rate of water into the pit was relatively constant at approximately 0.50 gallons per minute (gpm). The water was shut off and the water in the pit was allowed to infiltrate. The water depth was approximately 3.58 ft when the water was shut off. Based on the procedure described in Appendix V-B of the WDOE 2001 Stormwater Manual (WDOE 2001), the short-term insitu field infiltration rate would be approximately 2 inches per hour (0.5 gpm/22.8 ft^2).

Periodic measurements of the water level were made as the water in the pit infiltrated. During the first 3 hours and 45 minutes of the test, the water level dropped approximately 0.08 feet, for an average rate of approximately 0.25 inch per hour. A data logger was then installed to monitor the water level in the pit over the night. Periodic visual measurements were made to verify the data logger measurements. After approximately 17½ hours of monitoring, the water level in the pit had dropped a total of 2.4 inches. The test was suspended after 17½ hours, and the pit was drained and backfilled. The average insitu infiltration rate over the 17½ hour period was computed at 0.13 inches per hour. Approximately 0.03 inches of precipitation was recorded for October 5 and 6, 2004 at SeaTac International Airport. In our opinion, this amount of precipitation is insignificant and had no effect on the test.

Review of the field data indicates that the 2-inches per hour rate (as calculated by the steady flow/pond bottom) is representative of water infiltrating laterally into the soil at a very shallow depth. Once the water was shut off, the water level in the pit dropped at an average rate of about 1/4 inch per hour over the first four hours of the test. Over the remainder of the test, the rate at which the water dropped in the pit slowly declined to an average of about 0.13 inches per hour. It is our opinion that the 0.25 inch per hour rate is more representative of the actual insitu infiltration rate for a pond with a bottom at 5 ft. Therefore, we recommend that the insitu infiltration rate be 0.25 inches per hour.

Table 3.9 of the WDOE 2001 Stormwater Manual (WDOE 2001) provides recommended correction factors to be applied to the insitu field rate to account for site variability and operating conditions. The correction factor for site variability is between 1.5 to 6; the correction factor for maintenance is between 2 to 6; and the correction factor for pretreatment is between 2 to 6. The factors are summed. Therefore, the minimum correction factor applied to the insitu rate would be: 1.5 + 2 + 2 = 5.5. Applying the minimum factor, the design infiltration rate would be about 0.05 inches per hour.

In our opinion, infiltration at Site 1 is likely not feasible. The soil exposed at the planned infiltration pond bottom consists of medium dense sand with silt. Native soil of this type is generally amenable for infiltration, but the soil consists of compacted fill. It has been our past experience that insitu infiltration rates of compacted fill materials can be as much as 1 to 2 orders of magnitude less than a natural soil deposit of the same soil type. There appears to be no advantage in deepening the infiltration pond bottom to reach native soil. The explorations indicate that soil conditions become siltier with depth, and groundwater was present in the boring (KQ-1-04) below a depth of about 12½ ft.

3.2 SITE 2

The pit for the PIT 2 test was excavated to a depth of approximately 7 ft below the existing ground surface, as measured on the west (low) side of the pit. The pit was excavated an additional 2 ft below the planned test depth of 5 ft because of the presence of a clayey silt layer, approximately 2 ft in thickness, that was encountered at a depth of about 4 ft. The bottom area of the pit was approximately 27 ft^2. The pit side walls were excavated near vertical to a height of 4 ft above the bottom, with upper portions of the pit side walls laid back at an approximate 45 degree angle.

After cleaning the loose soil from the pit bottom, the instrumentation was installed and the pit was filled with water to a depth of approximately 3.3 ft above the bottom. Approximately 40 minutes was necessary to fill the pit with water. Water was continually added to the pit to maintain a constant water level at approximately 3.3 ft. After about 2 hours, the measured flow rate of water into the pit was relatively constant at approximately 4.5 gpm. The rate remained stable for an additional 1 hour and 15 minutes. The water was shut off and the water in the pit was allowed to infiltrate. The water depth was approximately 3.25 ft when the water was shut off. Based on the procedure described in Appendix V-B of the WDOE 2001 Stormwater Manual (WDOE 2001), the short-term insitu field infiltration rate would be approximately 16 inches per hour (4.5 gpm/27 ft^2).

A data logger was also installed to monitor the water level in the pit during the test. Periodic visual measurements were made to verify the data logger measurements. After approximately 25 minutes, the water level in the pit dropped 0.35 ft, giving an initial average infiltration rate of approximately 10 inches per hour. After approximately 3 hours and 11 minutes, the water level had dropped 2.01 ft, giving an average infiltration rate of approximately 7.6 inches per hour. Readings from the data logger over the same period indicated similar drops in the water level in the pit. During the night, the water level in the pit was monitored using the data logger. According to the data logger, the water level dropped to zero after approximately 7½ hours. Measurements from the data logger indicated an average infiltration rate of approximately 6.7 inches per hour over the length of the test. No precipitation was recorded in the area during the test period.

Representative soil samples were obtained of the soil below the bottom of the pit for PIT 2 (8½ ft) and at a depth of about 10 ft. Soil samples were also obtained from test pit TP-2A at about the same depths. The soil samples were analyzed to determine their grain size distribution to determine the USDA textual classification for correlation to estimated long-term infiltration rates. The results of the grain size analyses are presented in Appendix A of this report. The results of the grain size analyses indicate that the soil below the bottom of PIT 2 and the soil from TP-2A below a depth of about 5½ ft classifies as SAND per the USDA Soil Classification System. According to Table 3.7 in the WDOE 2001 Stormwater Manual (WDOE 2001), a soil with a SAND classification has an estimated short-term infiltration rate of 8 inches per hour.

In our opinion, infiltration of stormwater at Site 2 is feasible. Based on the results of the test, we recommend an insitu infiltration rate corresponding to the initial short-term infiltration rate of 16 inches per hour. Appropriate correction factors, listed in Table 3.9 of the WDOE 2001 Stormwater Manual (WDOE 2001), need to be applied to the insitu infiltration rate to account for site variability and long-term operating conditions. We understand that the proposed facility will be an infiltration trench, which is a long, linear feature. Only two test pits were excavated to characterize soil and groundwater conditions for this study. At this time, there is insufficient data to determine if the conditions observed in the two test pits are representative of actual conditions along the proposed infiltration trench. Considerable site variability is possible along the length of the trench. Of particular concern is the 2-ft thick silt layer that was encountered in the PIT 2 excavation (test pit TP-2B) at a depth of about 4 ft, and in test pit TP-2A, excavated about 35 ft south of the PIT 2 test, at a depth of about 5 ft. If present below the bottom of the infiltration trench, the silt will act as an aquitard, generally inhibiting infiltration. Also, groundwater may become perched on the silt layer during the winter/spring months, further inhibiting infiltration. The silt layer may be present at variable depth and extend (horizontally and vertically) over the length of the proposed bioswale/infiltration trench. If present, near the bottom of the infiltration trench, the silt layer will generally inhibit infiltration.

Because of the potential for site variability, we recommend using a site variability factor of 4 at this time. Assuming a high degree of long-term maintenance and reliable pretreatment to reduce total suspended solids, a correction factor of 2 for these two items is appropriate. Therefore, the recommended correction factor for predesign is 4+2+2 = 8. Applying the minimum factor, the design infiltration rate would be about 2 inches per hour.

To address the uncertainty in soil conditions, we recommend that additional test pits/borings be completed about every 50 to 75 ft along the length of the bioswale/infiltration trench to investigate if the silt layer is present, and if present, at what depth. The excavations should penetrate at least 5 ft below the proposed bottom of the infiltration trench. Representative soil samples of the soil below the base of the proposed trench should be obtained from the explorations and tested to determine the USDA soil textural classification. The results of the soil test should be compared to grain-size analyses of soil samples tested for this investigation. If conditions in the additional explorations are similar to conditions observed in the test pits excavated for this study, then the site variability correction factor could be reduced. If conditions are substantially different, then additional insitu infiltration testing may be warranted.

If the additional explorations indicate that the silt layer is present within a depth of about 5 ft below the infiltration trench bottom, the layer should be overexcavated. The overexcavation should be backfilled with a free-draining material, such as Gravel Backfill for Walls meeting the gradation requirements in Section 9-03.12(2) of the 2004 WSDOT Standard Specifications (WSDOT 2004). Over compaction of the material should be avoided. We suggest compacting the material by lightly tamping with the excavator bucket.

3.3 SITE 3

In our opinion, infiltration at Site 3 is infeasible. Three test pits, TP-3A through TP-3C, were excavated along the length of the proposed infiltration facility at Site 3. Groundwater seepage was encountered in all the test pits above the planned bottom depth of 5 ft below existing grades.

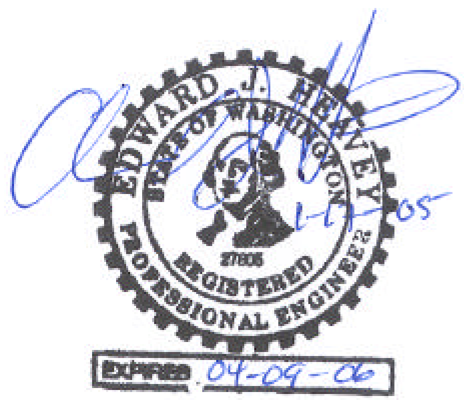
4.0 USE OF THIS REPORT

This report was prepared for the exclusive use of the I-405 Project Team for specific application to the proposed I-405 project. The use by others, or for purposes other than intended, is at the user's sole risk. The findings, conclusions, and recommendations presented herein are based on our understanding of the project and on subsurface conditions observed during our site investigations completed between October 5 and 21, 2004. Within the limitations of scope, schedule, and budget, the conclusions and recommendations presented in this report were prepared in accordance with generally accepted geotechnical engineering principles and practices in the area at the time the report was prepared. We make no other warranty either express or implied.

We appreciate the opportunity to provide geotechnical services on this project and look forward to assisting the I-405 Project Team as the design progresses. If you have any questions or comments regarding the information contained in this report, or if we may be of further service, please call.

LANDAU ASSOCIATES, INC.

Edward J. Heavey, P.E.
Associate



Dennis R. Stettler, P.E.
Principal

EJH/DRS/jas

5.0 REFERENCES

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Washington State Department of Transportation (WSDOT). 2004. *2004 Standard Specifications for Road, Bridge, and Municipal Construction*.

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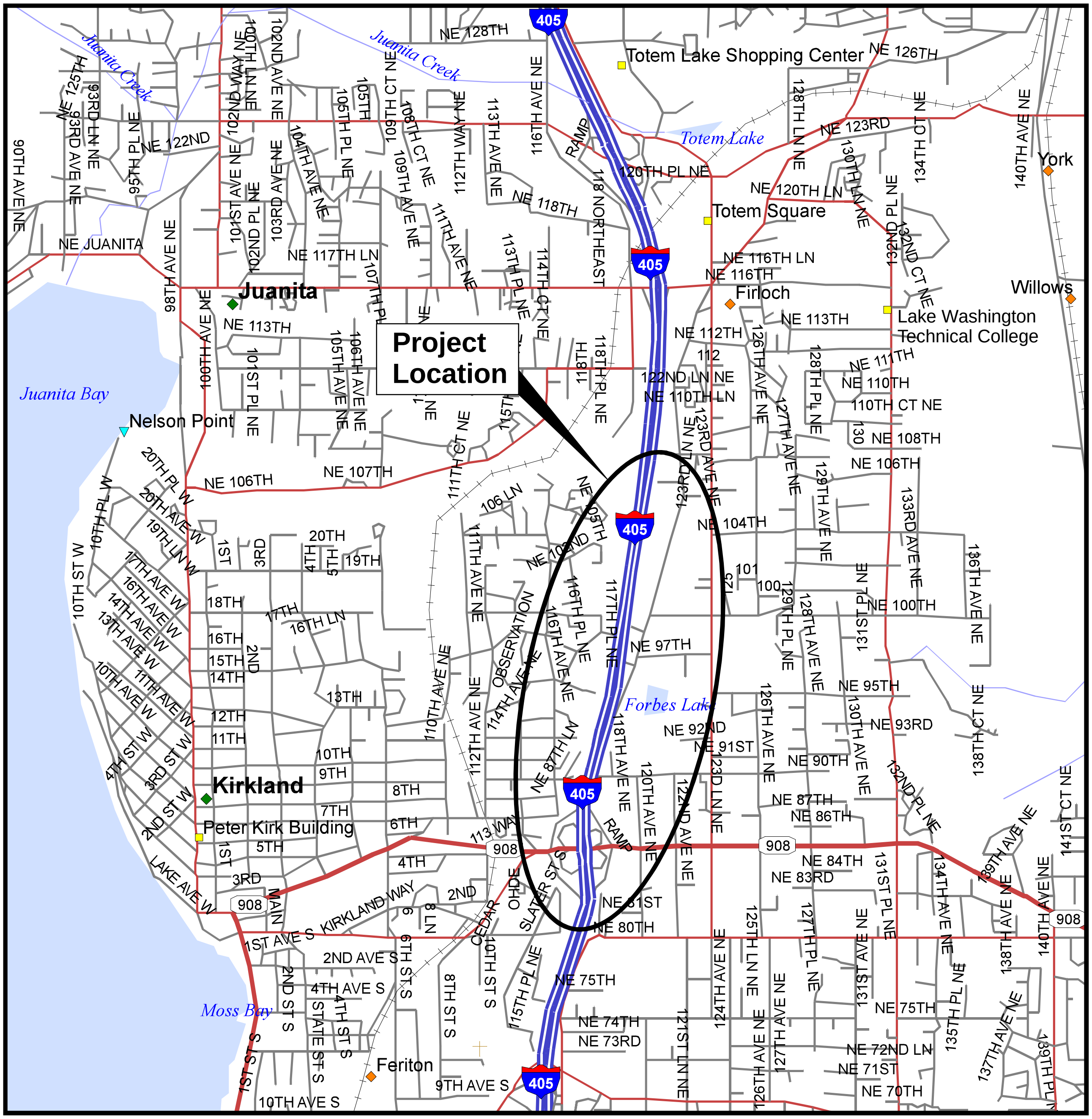

Map from DeLorme Street Atlas USA, 2002

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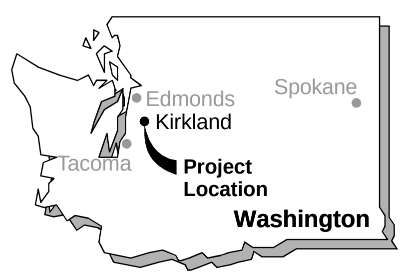
Scale in Miles



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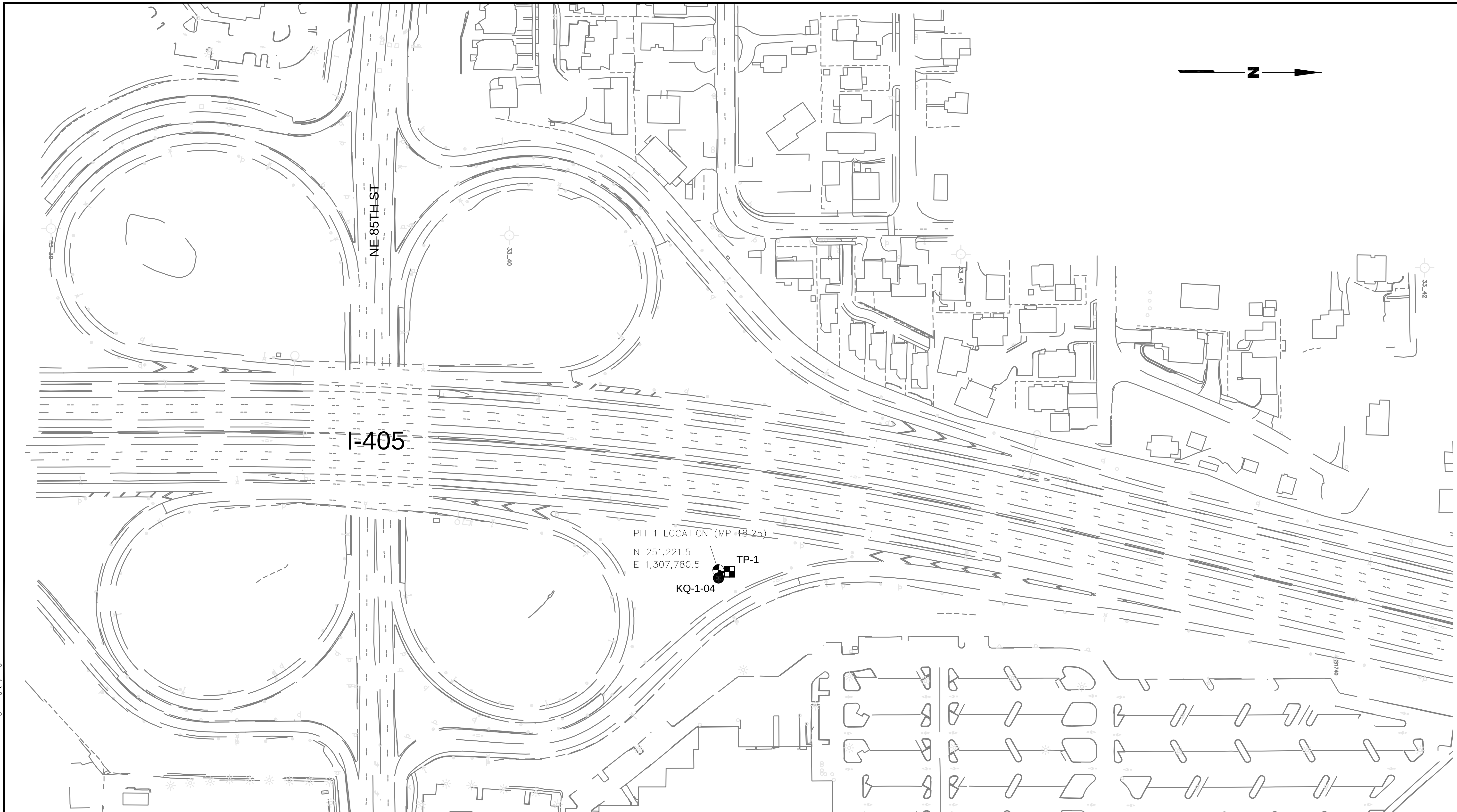
I-405 Stormwater Infiltration Kirkland Project Kirkland, Washington	**Vicinity Map**	Figure 1



Legend

TP-1 Approximate Test Pit Location and Designation

Approximate Location of PIT

KQ-1-04 Approximate Location of Borings by Others

0 150 300

Scale in Feet

Base map source: WSDOT, 2004

I-405 Stormwater Infiltration Kirkland Project Kirkland, Washington	**Site and Exploration Plan** **Site 1**	Figure 2

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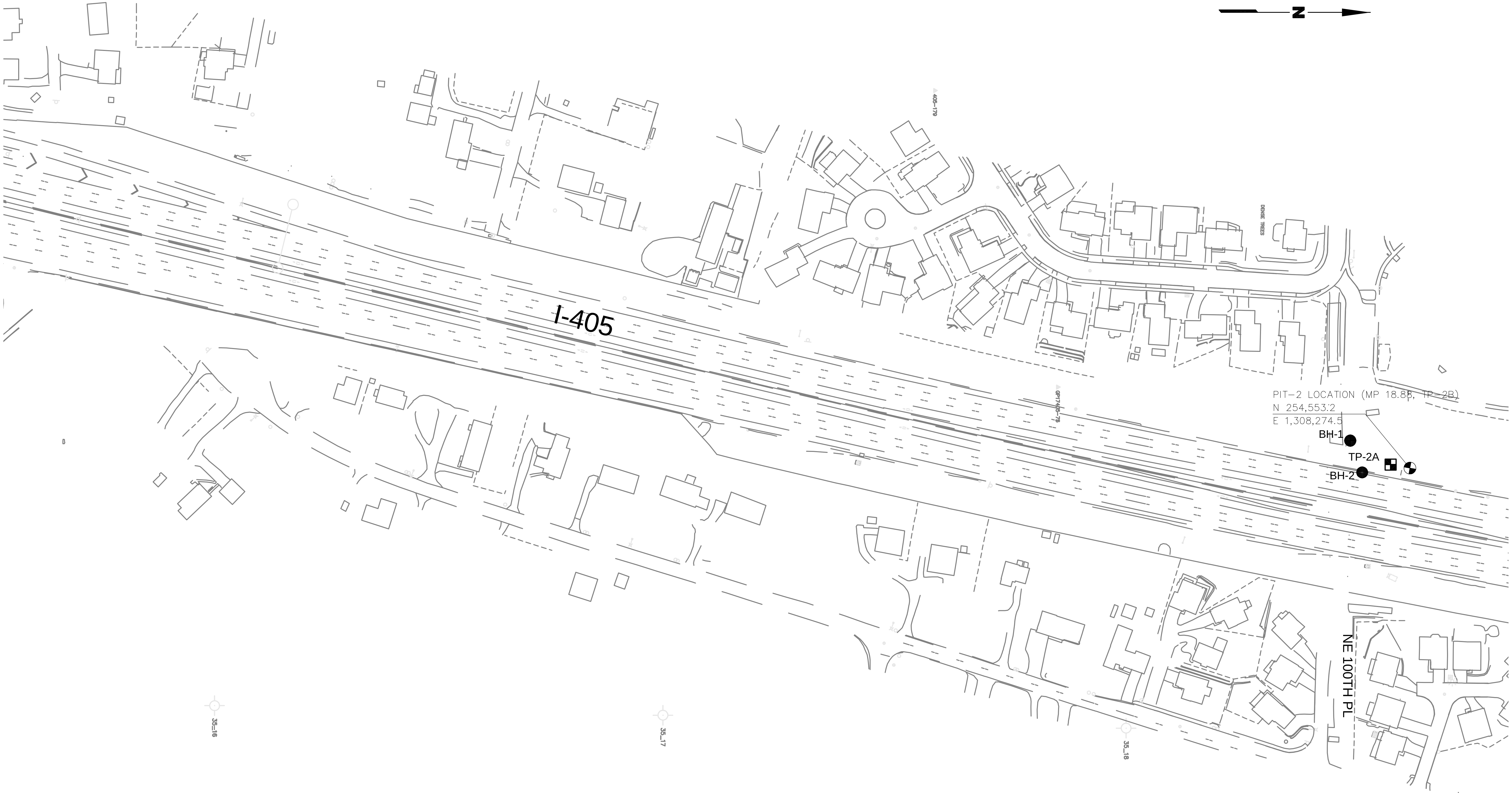

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TP-1 Approximate Test Pit Location and Designation

Approximate Location of PIT

BH-1 Approximate Location of Borings by Others

0 150 300
Scale in Feet

Base map source: WSDOT, 2004

I-405 Stormwater Infiltration
Kirkland Project
Kirkland, Washington

Site and Exploration Plan
Site 2

Figure
3

Landau Associates

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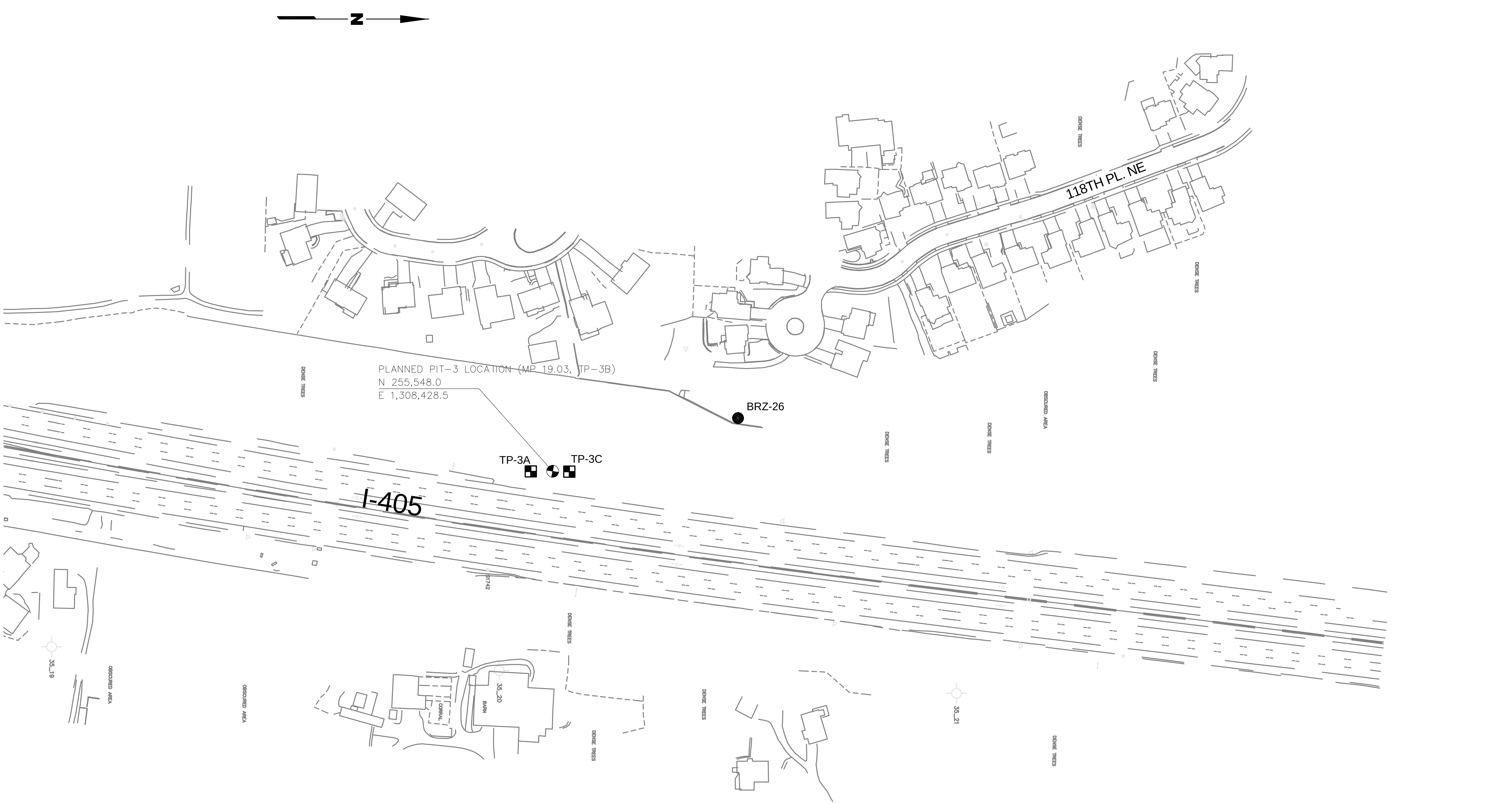

Legend

TP-1 Approximate Test Pit Location and Designation

Approximate Location of PIT

BRZ-26 Approximate Location of Borings by Others

0 150 300

Scale in Feet

Base map source: WSDOT, 2004

I-405 Stormwater Infiltration Kirkland Project Kirkland, Washington	**Site and Exploration Plan Site 3**	Figure 4

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Figure 5 - Set up at PIT 1

Figure 6 - PIT 1 Filling With Water

Figure 7 - PIT 1 After Draining

Figure 8 – PIT 2 After Draining – Note Silt Layer (Blue) on Wall

Figure 9 - Test Pit 2B. Note Silt Layer (blue) on Test Pit Wall

Figure 10 - Seepage in PIT 3A

Figure 11 - Seepage in PIT 3B

Figure 12 - Seepage at PIT 3C

APPENDIX A

Field Explorations and Geotechnical Laboratory Testing

APPENDIX A

FIELD EXPLORATIONS AND GEOTECHNICAL LABORATORY TESTING

FIELD EXPLORATIONS

Field explorations and insitu infiltration testing were completed between October 5 and 21, 2004 at the locations shown on Figures 2, 3, and 4. The PIT locations were identified by and field-located by WSDOT. Prior to the field explorations, underground utility checks were completed by WSDOT. WSDOT Maintenance Department provided equipment and personnel for traffic control, excavation, and water supply. The locations of the infiltration pits and the test pit explorations were field-located using a Trimble Pro-XRS mapping grade GPS survey.

Infiltration testing was completed in accordance with the procedure listed in Appendix V-B in the 2001 WDOE Stormwater Manual (WDOE 2001). The following describes the general procedure at PIT 1 and PIT 2 locations:

- A pit was excavated to the target depth using a rubber-tired backhoe. The bottom of the test pit was approximately 5 ft square.

- Loose soil was cleaned from the bottom of the pit and the dimensions of the pit were measured and recorded.

- A six-inch diameter PVC pipe with a tee at the base was placed in the pit to control water inflow to the pit excavation and to minimize bottom scour and excess suspension of sediment in the water pit. The PVC pipe extended from roughly the pit center at a 45 degree angle to the top of the pit.

- The pit was filled with water to a depth of about 3 to 3½ ft above the pit bottom. Water was supplied by a 2,500 gallon water tank truck. Water was added at approximately 20 to 30 gallons per minute during the initial water filling of the infiltration pits.

- Water was continually added to the pit until the flow rate of water into the pit became relatively constant. An inline flow meter, attached to the water delivery hose, was used to monitor water inflow into the pit. The flow meter measured flow in one-tenth gallon increments.

- Water levels in the pit were monitored with two methods: a water level data logger with electronic pressure transducers was used for electronic water level measurements (tenths of inches increments) and a stadia gage rod (one hundreds foot increments) for direct water level measurements. Both were installed on a 2 x 4 post, securely anchored in the pit.

- Upon completion of the test, the bottom of the pit was excavated to check for the presence of low permeable layers and to obtain a soil sample from the pit bottom.

- After completion of testing, the pit was backfilled with excavated soil.

- A test pit was excavated adjacent to the PIT location for the purpose of detailed logging of soil conditions.

At PIT location 3, groundwater was encountered above the planned infiltration facility bottom. Insitu infiltration testing was not completed at PIT location 3.

The explorations and infiltration testing were coordinated and monitored by a geologist from our firm who also obtained representative soil samples, maintained a detailed record of observed subsurface soil and groundwater conditions, and described the soil encountered by visual examination and laboratory testing. Representative bulk soil samples were obtained from the test pits, placed in air-tight plastic bags, and returned to our laboratory for further classification and laboratory testing.

Each representative soil type observed was described using the soil classification system shown on Figure A-1 in this appendix, and in general accordance with ASTM D 2488, *Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)*. Logs of the explorations are presented on Figures A-2 through A-4. Theses logs represent our interpretation of subsurface conditions identified during the field explorations. The stratigraphic contacts shown on the individual logs represent the approximate boundaries between soil types; actual transitions may be more gradual. Also, the soil and groundwater conditions depicted are only for the specific date and locations reported, and therefore, are not necessarily representative of other locations and times.

Soil samples obtained from the explorations will be stored in our laboratory for 30 days after the date of the final report. After that date, the samples will be disposed of unless arrangements are made to retain them.

GEOTECHNICAL LABORATORY TESTING

Combined analyses (mechanical sieve and hydrometer analyses) were performed on selected soil samples recovered from the test pits in general accordance with ASTM D422 to provide an indication of their grain size distribution. Laboratory testing was performed in general accordance with the American Society for Testing and Materials (ASTM) standard test procedures. Soil samples were checked against the field log descriptions, which were updated where appropriate in general accordance with ASTM D2487, *Standard Test Method for Classification of Soils for Engineering Purposes*. The results of the sieve analyses are presented on Figure A-5. Figure A-6 provides the U. S. Department of Agriculture Soil Conservation Service classification for the samples. Samples on which grain size analyses were completed are designated with “GS” in the column labeled “Test Data” on the summary logs in Appendix A.

Soil Classification System

MAJOR DIVISIONS			USCS LETTER SYMBOL[1]	TYPICAL DESCRIPTIONS[2][3]
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL (More than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (Little or no fines)	GW	Well-graded gravel; gravel/sand mixture(s); little or no fines
			GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines
		GRAVEL WITH FINES (Appreciable amount of fines)	GM	Silty gravel; gravel/sand/silt mixture(s)
			GC	Clayey gravel; gravel/sand/clay mixture(s)
	SAND AND SANDY SOIL (More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)	SW	Well-graded sand; gravelly sand; little or no fines
			SP	Poorly graded sand; gravelly sand; little or no fines
		SAND WITH FINES (Appreciable amount of fines)	SM	Silty sand; sand/silt mixture(s)
			SC	Clayey sand; sand/clay mixture(s)
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)		ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity
			CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay
			OL	Organic silt; organic, silty clay of low plasticity
	SILT AND CLAY (Liquid limit greater than 50)		MH	Inorganic silt; micaceous or diatomaceous fine sand
			CH	Inorganic clay of high plasticity; fat clay
			OH	Organic clay of medium to high plasticity; organic silt
	HIGHLY ORGANIC SOIL		PT	Peat; humus; swamp soil with high organic content

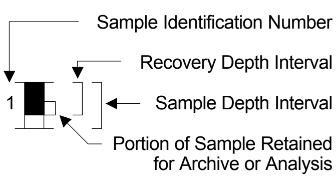
OTHER MATERIALS	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT	AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK	RK	Rock (See Rock Classification)
WOOD	WD	Wood, lumber, wood chips
DEBRIS	DB	Construction debris, garbage

Notes:
1. USCS letter symbols correspond to the symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM) for a sand or gravel indicate a soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
2. Soil descriptions are based on the general approach presented in the *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*, as outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the *Standard Test Method for Classification of Soils for Engineering Purposes*, as outlined in ASTM D 2487.
3. Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent:	> 50%	- "GRAVEL," "SAND," "SILT," "CLAY," etc.
Secondary Constituents:	> 30% and ≤ 50%	- "very gravelly," "very sandy," "very silty," etc.
	> 15% and ≤ 30%	- "gravelly," "sandy," "silty," etc.
Additional Constituents:	> 5% and ≤ 15%	- "with gravel," "with sand," "with silt," etc.
	≤ 5%	- "trace gravel," "trace sand," "trace silt," etc., or not noted.

Drilling and Sampling Key

SAMPLE NUMBER & INTERVAL



SAMPLER TYPE

Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon
c	Shelby Tube
d	Grab Sample
e	Other - See text if applicable
1	300-lb Hammer, 30-inch Drop
2	140-lb Hammer, 30-inch Drop
3	Pushed
4	Other - See text if applicable

Groundwater

▽ ATD Approximate water elevation at time of drilling (ATD) or on date noted. Groundwater levels can fluctuate due to precipitation, seasonal conditions, and other factors.

Field and Lab Test Data

Code	Description
PP = 1.0	Pocket Penetrometer, tsf
TV = 0.5	Torvane, tsf
PID = 100	Photoionization Detector VOC screening, ppm
W = 10	Moisture Content, %
D = 120	Dry Density, pcf
-200 = 60	Material smaller than No. 200 sieve, %
GS	Grain Size - See separate figure for data
AL	Atterberg Limits - See separate figure for data
GT	Other Geotechnical Testing
CA	Chemical Analysis

11/18/04 Y:\244\034.010\244034.GPJ SOIL CLASS SHEET

LANDAU ASSOCIATES

I-405 Stormwater Infiltration Kirkland Project
Kirkland, Washington

Soil Classification System and Key

Figure A-1

TP-1

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not measured	
0					SM	Sod	Groundwater not encountered.
	S-1	d4				Light brown to gray, silty, gravelly, fine to medium SAND with trace debris (asphalt and brick)(medium dense, moist) (fill)	
	S-2	d4			SM		
	S-3	d4			SP-SM	Light brown to reddish brown, very silty, fine SAND with trace fine gravel (medium dense, moist) (fill)	
5	S-4	d4			SP-SM	Light brown, fine SAND with silt and gravel (medium dense, moist) (fill)	
	S-5	d4			SP-SM	Light reddish brown, fine SAND with silt (dense, moist) (fill)	
						Gray, gravelly, fine SAND with silt (loose to medium dense, moist) (recessional deposit)	
10					SM	Gray, silty, fine SAND with trace gravel (medium dense to dense, moist) (recessional deposit)	
	S-6	d4					
	S-7	d4			SM	Gray, silty, gravelly, fine to medium SAND to gravelly, silty, fine to medium SAND (very dense, moist) (glacial till)	
	S-8	d4					

Test Pit Completed 10/05/04
Total Depth of Test Pit = 13.8 ft.

TP-2A

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not measured	
0					SP-SM	Sod	
	S-1	d4			SP-SM	Light brown, gravelly, fine to medium SAND with silt (medium dense, moist) (fill)	
	S-2	d4				Light brown, gravelly, fine SAND with silt (medium dense, moist) (advance outwash)	
	S-3	d4			SP	Light brown, fine SAND with trace silt (dense, wet) (advance outwash)	Slight groundwater seepage encountered at 4.5 ft.
5	S-4	d4	W = 24 GS		ML	Gray to reddish brown, clayey, SILT (hard, moist) (advance outwash)	
	S-5	d4					
					SP	Light reddish brown, fine to medium SAND with trace silt (dense, moist) (advance outwash) - interbedded clayey SILT (6 inch layer)	
10	S-6	d4	W = 7 GS				

Test Pit Completed 10/12/04
Total Depth of Test Pit = 11.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

244034.01 11/18/04 Y:\244\034.010\244034.GPJ TEST PIT LOG

LANDAU ASSOCIATES

I-405 Stormwater Infiltration Kirkland Project Kirkland, Washington	Log of Test Pits	Figure A-2

TP-2B

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not measured	
0					SM	Sod	
					SP-SM	Dark brown, silty fine SAND with abundent roots (loose, wet) (topsoil)	
	S-1	d4				Light reddish brown, fine SAND with silt and fine gravel (medium dense to dense, moist to wet) (advance outwash)	Slight groundwater seepage encountered at 3.8 ft.
5	S-2	d4			ML	Light reddish brown to gray, SILT with scattered lenses of fine gravelly, fine to medium sandy SILT with iron staining (hard, moist) (advance outwash)	
	S-3	d4	7 feet - Bottom of Infiltration Pit		SM	Light reddish brown, fine SAND with silt (dense, moist) (advance outwash)	
	S-4	d4			SP	Light brown, fine to medium SAND with trace silt (dense, moist) (advance outwash)	
	S-5	d4	W = 7 GS				
10	S-6	d4	W = 7 GS				
	S-7	d4					
	S-8	d4					

Test Pit Completed 10/12/04
Total Depth of Test Pit = 11.5 ft.

15

TP-3A

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe Ground Elevation (ft): Not measured	
0	S-1	d4			ML	Sod	
	S-2	d4			SP/SM	Dark brown, fine sandy, SILT with gravel and abundent fine organics and roots (soft, wet) (topsoil)	Slight groundwater seepage encountered at 2.5 ft.
	S-3	d4			SM	Light brown, gravelly, fine to medium SAND with silt to silty, gravelly, fine to medium SAND; fill thickness increases east and decreases west - upslope (medium dense, wet) (fill)	
5	S-4	d4					
	S-5	d4			SP-SM	Light brown, gravelly, silty, fine SAND (medium dense to dense, moist to wet) (advance outwash)	Moderate groundwater seepage encountered at 6.5 ft.
	S-6	d4			SP-SM	Light brown, fine SAND with silt and trace medium sand and gravel and interbedded gravelly, silty, fine SAND (dense, wet) (advance outwash)	
10						Light brown, fine to medium SAND with silt and trace coarse sand and iron-staining (dense to very dense, wet) (advance outwash)	

Test Pit Completed 10/21/04
Total Depth of Test Pit = 9.0 ft.

15

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

LANDAU ASSOCIATES

I-405 Stormwater Infiltration Kirkland Project Kirkland, Washington	Log of Test Pits	Figure A-3

TP-3B

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe; Ground Elevation (ft): Not measured	
0	S-1	d4			ML	Sod	
	S-2	d4			SP-SM	Dark brown, fine sandy, SILT with gravel and abundent fine organics and roots (soft, wet) (topsoil)	
	S-3	d4			SP-SM	Light brown, gravelly, fine to medium SAND with silt (loose to medium dense, moist to wet) (fill)	Moderate groundwater seepage encountered at 3.8 ft.
5	S-4	d4				Reddish brown to light brown, fine SAND with silt to trace silt (medium dense to dense, moist to wet) (advance outwash)	

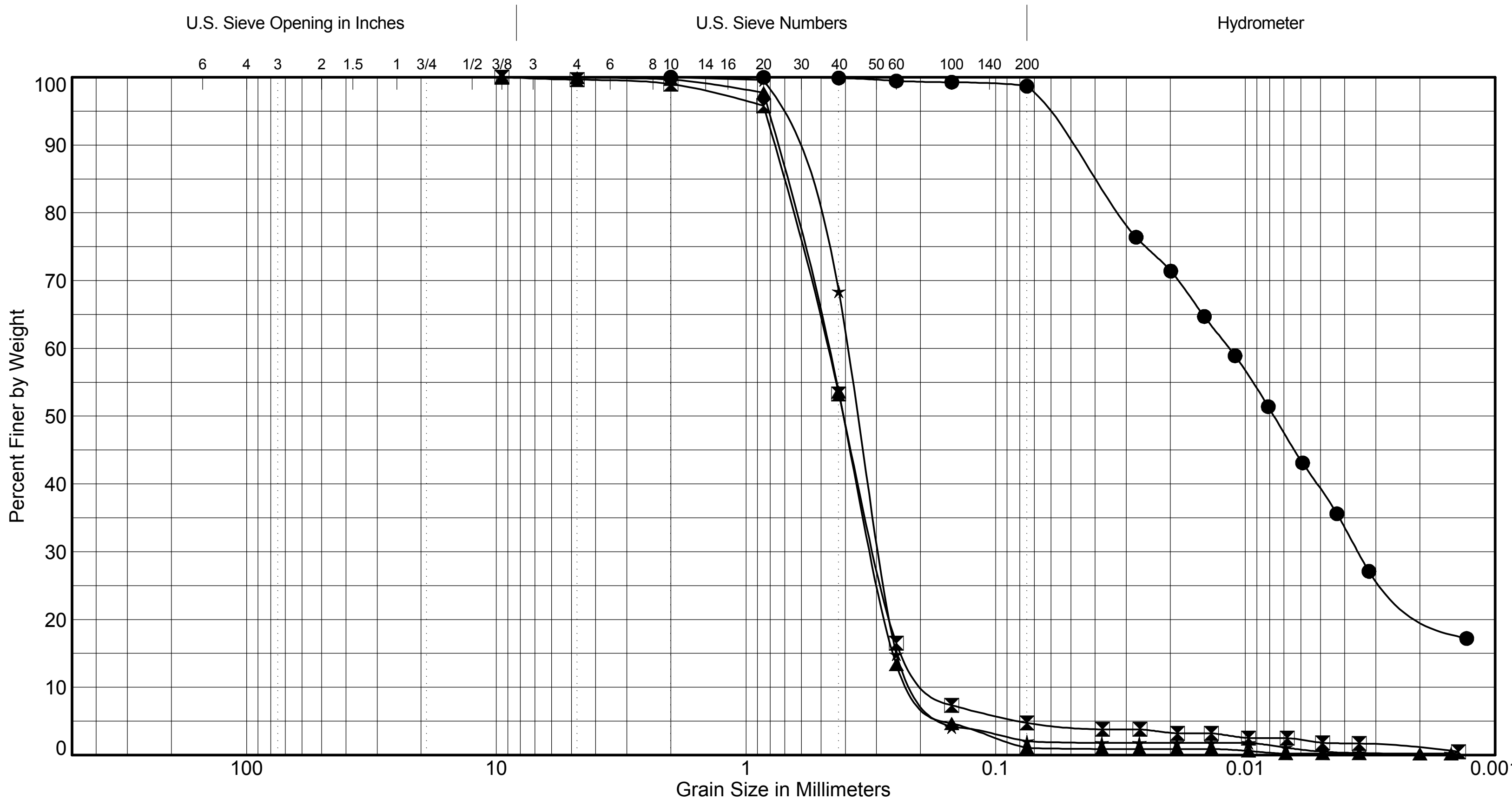
Test Pit Completed 10/21/04
Total Depth of Test Pit = 6.5 ft.

TP-3C

SAMPLE DATA				SOIL PROFILE			GROUNDWATER
Depth (ft)	Sample Number & Interval	Sampler Type	Test Data	Graphic Symbol	USCS Symbol	Excavation Method: Rubber-tired Backhoe; Ground Elevation (ft): Not measured	
0	S-1	d4			ML	Sod	
	S-2	d4			SP-SM	Dark brown, fine sandy, SILT with gravel and abundent fine organics and roots (soft, wet) (topsoil)	
	S-3	d4			SP-SM	Brown and gray, gravelly, fine to medium SAND with silt (loose to medium dense, wet) (fill)	Moderate groundwater seepage encountered at 4.0 ft.
5	S-4	d4				Light reddish brown, fine SAND with silt to trace silt (medium dense to dense, moist to wet) (advance outwash)	
	S-5	d4			SP-SM	- grading to light brown, fine SAND with trace silt	
						Light brown to light yellowish brown, fine SAND with silt (dense, wet) (advance outwash)	

Test Pit Completed 10/21/04
Total Depth of Test Pit = 8.0 ft.

Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

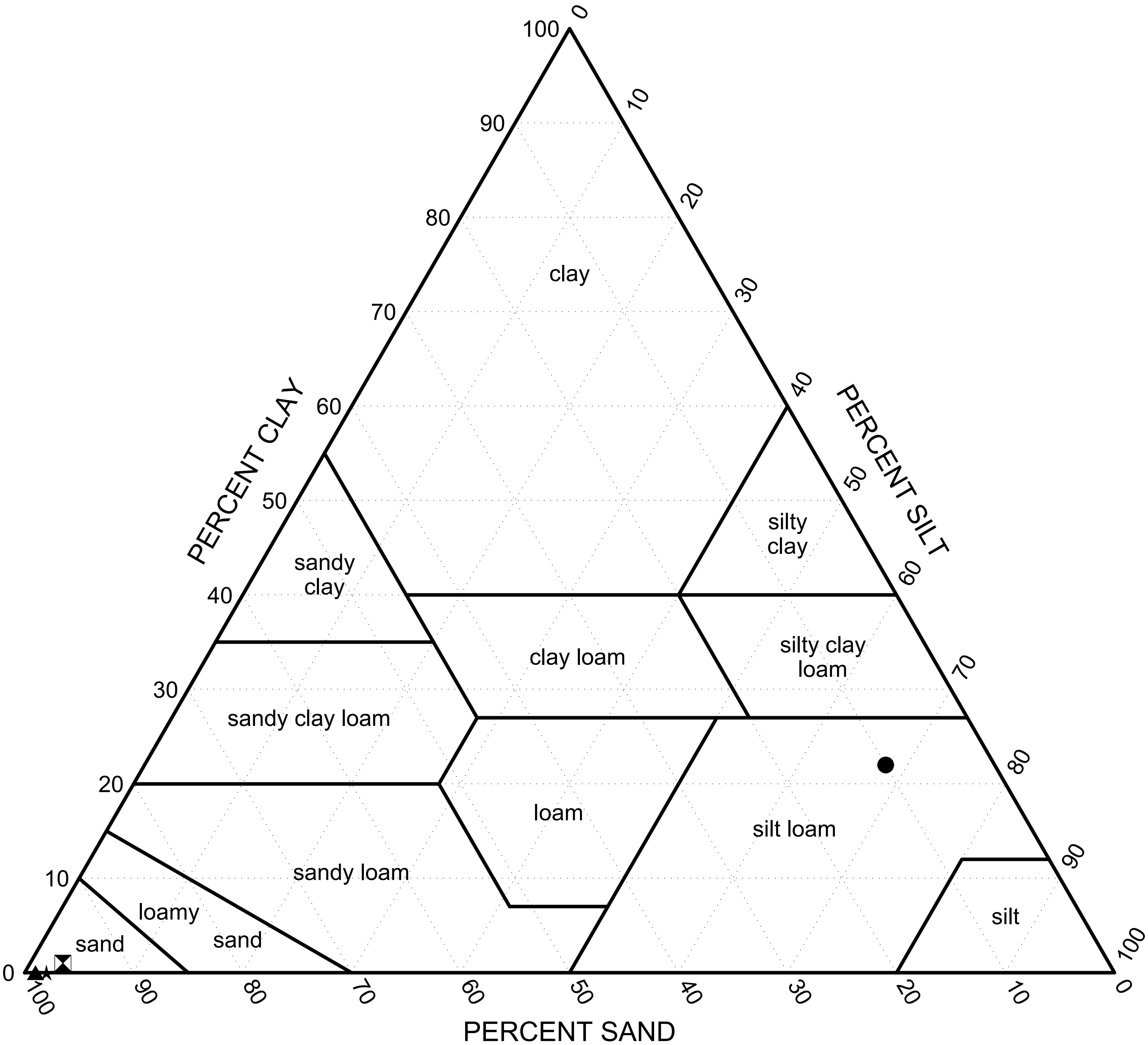
Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	TP-2A	S-4	5.5	24	Clayey, SILT	ML
⧗	TP-2A	S-6	10.0	7	Fine to medium SAND with trace silt	SP
▲	TP-2B	S-5	8.8	7	Fine to medium SAND with trace silt	SP
★	TP-2B	S-7	10.0	7	Fine to medium SAND with trace silt	SP

LANDAU ASSOCIATES

I-405 Stormwater Infiltration
Kirkland Project
Kirkland, Washington

Grain Size Distribution

Figure
A-5



	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	USDA Textural Classification	USCS Classification
●	TP-2A	S-4	5.5	24	SILT LOAM	ML
⧗	TP-2A	S-6	10.0	7	SAND	SP
▲	TP-2B	S-5	8.8	7	SAND	SP
★	TP-2B	S-7	10.0	7	SAND	SP

244034.01 11/18/04 Y:\2441034.010\244034.GPJ USDA TEXTURAL CLASSIFICATION

LANDAU ASSOCIATES

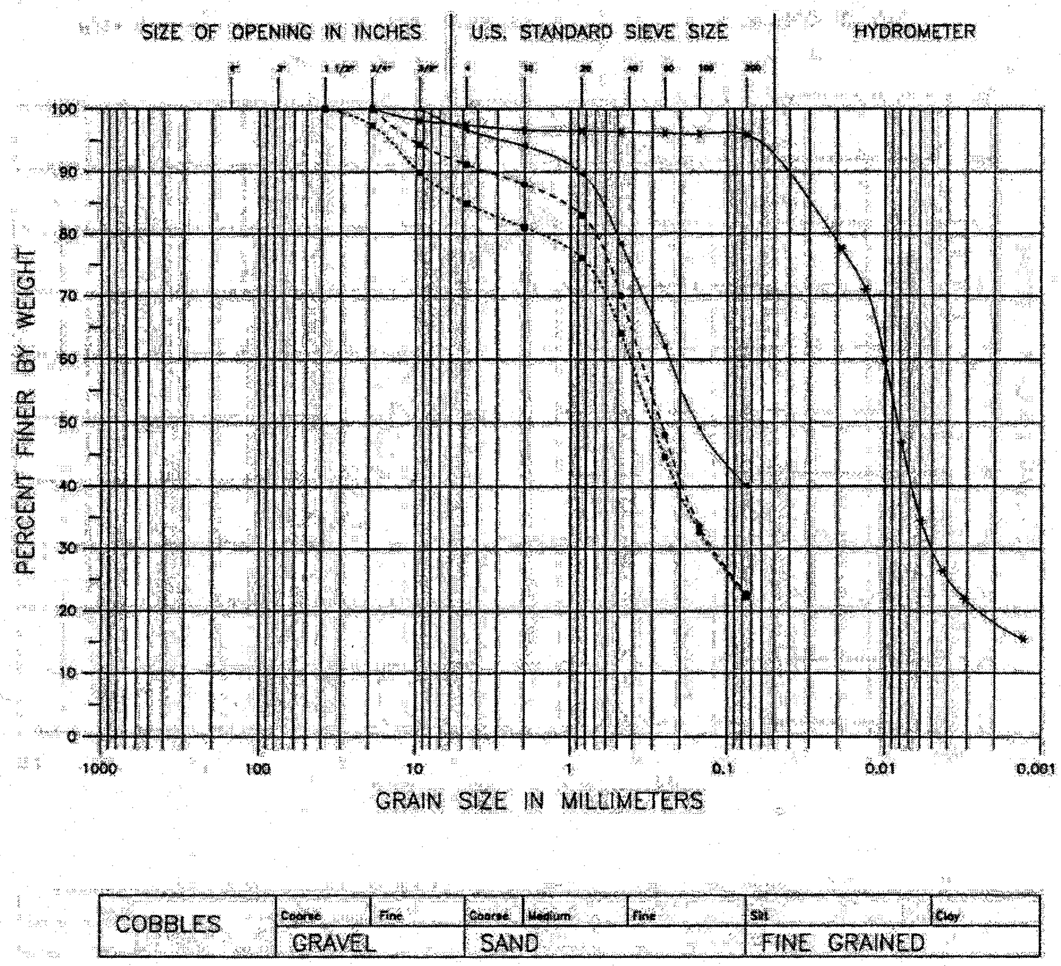
I-405 Stormwater Infiltration Kirkland Project Kirkland, Washington	USDA Textural Classification Chart	Figure A-6

APPENDIX B

WSDOT Boring Logs

PIT 3

GRAIN SIZE DISTRIBUTION



	Sample Type	Sample Number	Depth (Ft.)	Moisture	Fines	Soil Description
	BRZ-26	S-4	15'	27%	96%	
	BRZ-27	S-1	2.5'	9%	23%	
	BRZ-27	S-3	12.5'	12%	22%	
	BRZ-28	S-1	2.5'	14%	40%	

B - Boring Tp - Testpit Ha - Hand Auger Gb - Grab Bag X - Other

Project: SR-405 Northup to Bothell
Work Order: W-7148-1
Date: 3/26/91

RZA

RITTENHOUSE - ZEMAN & ASSOCIATES INC.
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue, Washington 98005

PIT 2

DRILLING COMPANY: WSDOT
DRILLING METHOD: CME-45C Skid Rig, mud rotary
SURFACE ELEVATION: 269 ± Feet

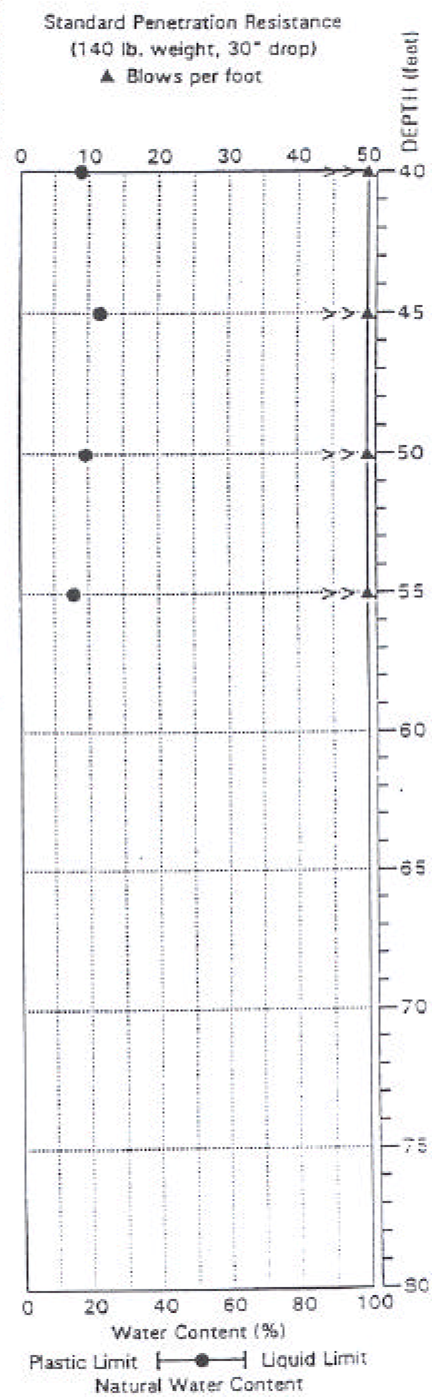
LOCATION: See Figure 2
DATE COMPLETED: 5/28/98
LOGGED BY: MBB

DEPTH (feet)	SYMBOL	ASTM SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
40		SP SM	Same as previous.		S-11	26-46-33	GS	
45			Trace fine subrounded gravel.		S-12	21-27-35		
50		SM	Very dense, dark grayish brown, silty fine to coarse SAND with gravel, moist. Fine to coarse subrounded gravel. Silt layer in tip of sampler.		S-13	50/4"		
55					S-14	10-18 50/4"		

End of boring at 56.5 feet.

Groundwater seepage observed at 13 feet at time of drilling.

Note: Sampler driven with automatic trip hammer.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

NE 100th Street Pedestrian Bridge
Kirkland, Washington

BORING: BH-2

PROJECT NO.: 98070 FIGURE: A-3

PIT 2

...LLING COMPANY: Gregory Drilling
...LLING METHOD: CME-850 HSA, hollow stem auger
...RFACE ELEVATION: 277 ± Feet

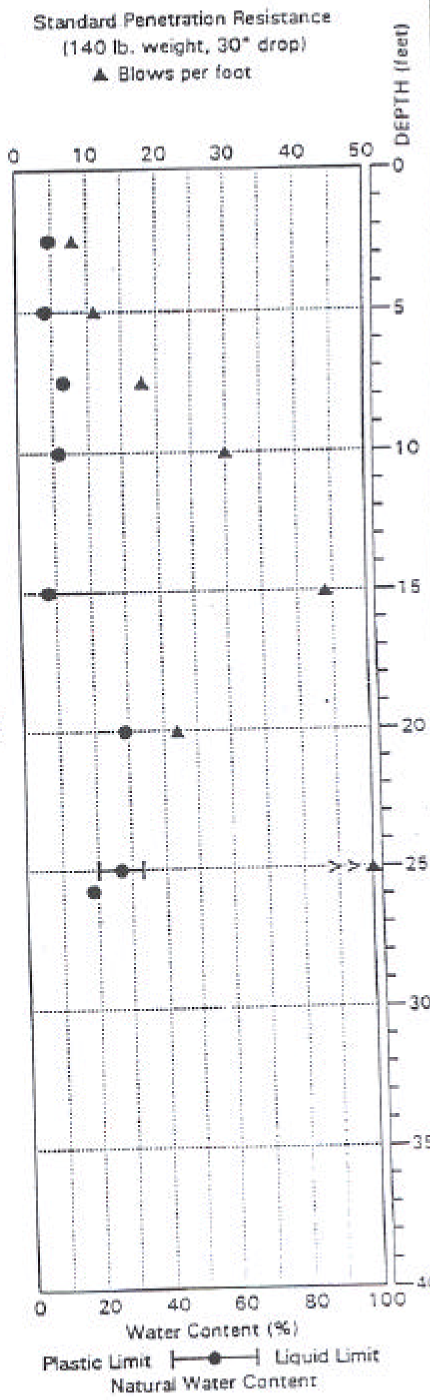
LOCATION: See Figure 2
DATE COMPLETED: 5/22/98
LOGGED BY: DLS

ASTM SOIL CLASS	DESCRIPTION	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
SW SM	Medium dense, olive brown, fine to coarse SAND with silt and gravel, moist. Fine gravel. (FILL)	S-1	4-3-5	GS	
		S-2	5-6-5		
SP	Medium dense to dense, brown, fine to coarse SAND with a trace silt, moist. (ADVANCE OUTWASH)	S-3	8-9-9		
		S-4	8-15-15		
	Occasional fine gravel.	S-5	12-21-23		
SM	Medium dense, olive brown, silty fine to coarse SAND, wet. Perched water.	S-6	10-11-11		▽
CL	Hard, dark gray, LEAN CLAY, moist.	S-7	10-29-31	AL	
SM	Very dense, brown, silty fine SAND, moist.				

End of boring at 26.5 feet.

Groundwater observed at 20 feet during drilling.

Note: Sampler driven with automatic trip hammer.



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC

NE 100th Street Pedestrian Bridge
Kirkland, Washington

BORING: BH-1

PAGE: 1 of 1

PROJECT NO.: 98070 FIGURE: A-2

Washington State Department of Transportation

LOG OF TEST BORING

PIT 1

Start Card R-62195

HOLE No. KQ-1-04

Job No. XL-2068 SR 405 Elevation 267.6 ft (81.6 m)

Sheet 2 of 2

Project Stage 1 Kirkland

Driller Sean Verlo Lic# 2615

Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Lab Tests	Description of Material
		15 20 (35)			reaction Length Recovered 0.9 ft, Length Retained 0.9 ft 07/23/2004 07/23/2004
	7				
25		21 25 32 (57)	D-10		Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction, With large gravel as indicated by drilling process. Length Recovered 1.2 ft, Length Retained 1.2 ft
	8				
	9	37 50/4 (50/4")	D-11	GS MC	SM, MC=11% Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction, With large gravel as indicated by drilling process. Length Recovered 0.9 ft, Length Retained 0.9 ft
30					
	10				
35		50/6 (50/6")	D-12		Silty SAND, very dense, gray, moist, Homogeneous, no HCl reaction, With large gravel as indicated by drilling process. Length Recovered 0.5 ft, Length Retained 0.5 ft
	11				
	12				
40		40 50/3 (50/3")	D-13	GS MC	SP-SM, MC=13% Poorly graded SAND with silt and gravel, very dense, gray, wet, Homogeneous, no HCl reaction, With large gravel as indicated by drilling process. Length Recovered 0.8 ft, Length Retained 0.8 ft
					End of test hole boring at 40.3 ft below ground elevation. This is a summary Log of Test Boring. Soil/Rock descriptions are derived from visual field identifications and laboratory test data. Bore hole water level before bailing 7.0', after bailed 37.0', after 10 minutes 27.2', after 20 minutes 25.1', after 30 minutes 23.7', water table stabilized at 20.2'.
	13				
45					

Columns also shown: Profile, Standard Penetration Blows/ft (10 20 30 40), Sample Type, Groundwater, Instrument.

>>

Washington State
Department of Transportation

LOG OF TEST BORING

PIT 1

Start Card R-62195

HOLE No. KQ-1-04

Sheet 1 of 2

Job No. XL-2068 SR 405 Elevation 267.6 ft (81.6 m)

Project Stage 1 Kirkland

Driller Sean Verlo Lic# 2615

Site Address Vic. SR 405 + NE 85th ST.

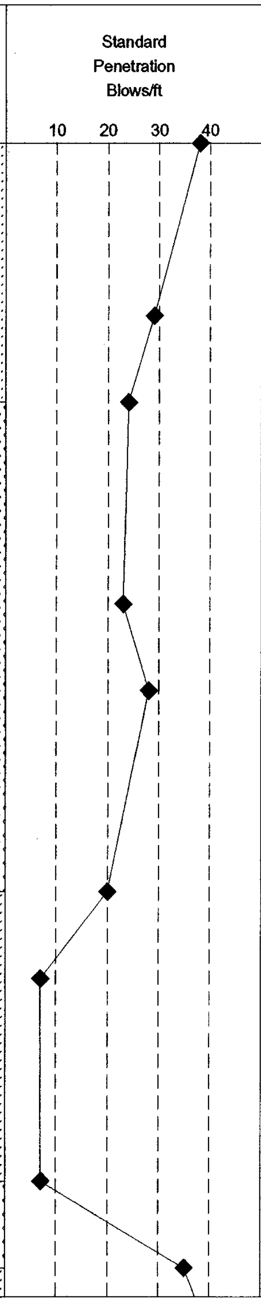
Inspector Don Henderson

Start July 23, 2004 Completion July 23, 2004 Well ID# AHN-837 Equipment CME 45 w/ autohammer

Station Offset Casing HW-4.5/HQ-3.5 Method Wet Rotary

Northing 251223.1 Easting 1307781.1 Latitude Longitude

County King Subsection NW 1/4 of the SW 1/4 Section 4 Range 5 EWM Township 25N



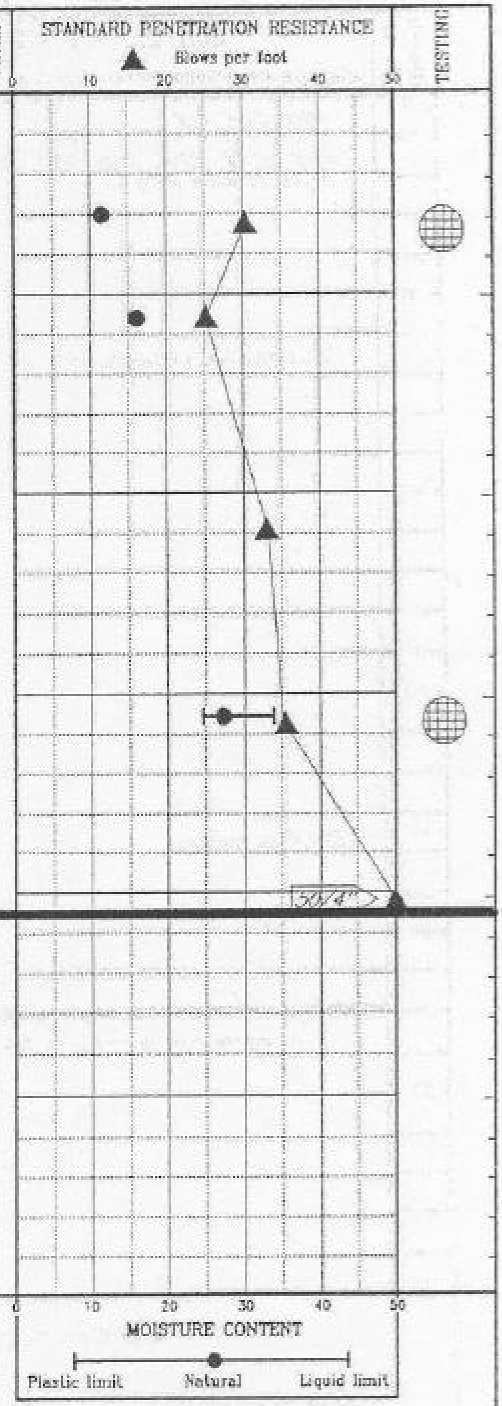
Depth (ft)	Meters (m)	SPT Blows/6" (N)	Sample No. (Tube No.)	Lab Tests	Description of Material
		17 22 16 (38)	D-1		Silty SAND, dense, Lt. Brown, dry, Homogeneous, no HCl reaction, Trace organics, With large gravel as indicated by drilling process. Length Recovered 1.5 ft, Length Retained 1.5 ft
	1	13 14 15 (29)	D-2	GS MC	SM, MC=10% Silty SAND, dense, Lt. Brown, dry, Homogeneous, no HCl reaction, With large gravel as indicated by drilling process. Length Recovered 1.5 ft, Length Retained 1.5 ft
5		7 11 13 (24)	D-3		Well graded SAND with silt, medium dense, gray, moist, Homogeneous, no HCl reaction Length Recovered 1.3 ft, Length Retained 1.3 ft
	2				
		14 11 12 (23)	D-4	GS MC	SW-SM, MC=9% Well graded SAND with silt, medium dense, gray, moist, Homogeneous, no HCl reaction Length Recovered 1.4 ft, Length Retained 1.4 ft
10	3	14 15 13 (28)	D-5		Well graded SAND with silt, dense, gray, moist, Homogeneous, no HCl reaction Length Recovered 1.2 ft, Length Retained 1.2 ft
	4	11 12 8 (20)	D-6		Silty SAND, medium dense, gray, wet, Homogeneous, no HCl reaction, Hit wet zone at 12.5. Length Recovered 1.1 ft, Length Retained 1.1 ft
15		5 4 3 (7)	D-7	GS MC	SM, MC=20% Silty SAND, loose, brown, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft
	5				
		3 3 4 (7)	D-8	GS MC	SW-SM, MC=18% Well graded SAND with silt and gravel, loose, gray, wet, Homogeneous, no HCl reaction Length Recovered 1.0 ft, Length Retained 1.0 ft
20	6	18	D-9		Silty SAND, dense, gray, moist, Homogeneous, no HCl

SOIL XL-2068.S 3E 1 KIRKLAND.GPJ SOIL.GDT 8/20/04 2:30:21 P8

PIT 3

PROJECT *SR-405: Northup to Bothell* W.O. *W 7148-1* BORING NO. *BRZ-26*

DEPTH (feet)	SOIL DESCRIPTION Approximate ground surface elevation: *239 feet*	SAMPLE TYPE	SAMPLE NUMBER	GROUND WATER	STANDARD PENETRATION RESISTANCE	TESTING
0	*Forest duff*					
	Medium dense to dense, moist, gray, fine to medium SAND with some silt and gravel (Fill)		S-1			Grain size analysis
5	*Relic topsoil*		S-2			
	Hard, moist to wet, blue-gray SILT with some sand and trace of gravel					
10			S-3			
15			S-4			Grain size analysis
20			S-5		50/4"	
	Boring terminated at 20.4 feet					
25						
30						



LEGEND

- 2-inch OD split spoon sampler
- Sample not recovered
- Grain size analysis
- Groundwater level at time of drilling
- CBR California bearing ratio test

RZA
RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
Geotechnical & Environmental Consultants
1400 140th Ave NE
Bellevue, Washington 98005

Drilling started: *5 April 1991* Drilling completed: *5 April 1991* Logged by: *CM/JDC*